

US Pat. App. Ser. No. 09/997,168
filed in response to Office Action of 7/6/2005

ATTORNEY DOCKET: D1815-00053

AMENDMENTS TO THE CLAIMS:

Claims Listing

1. (Currently Amended) A bolted or riveted mechanically fastened composite structural joint, comprising:

- (a) a substrate material having a fastener hole;
- (b) a multi-layered composite having a fastener hole, and
- (c) a bolt or rivet fastener disposed within the fastener holes of the substrate and composite materials to secure the materials together;

said multi-layered composite further including:

- (i) a pair of resin-impregnated, fiber-containing layers, having a first toughness, ~~and a first tensile modulus;~~
- (ii) a fiber-containing core layer having a second, greater toughness than said pair of resin-impregnated fiber-containing layers, ~~and a second tensile modulus that is lower than said first tensile modulus;~~ said fiber-containing core layer sandwiched between said pair of resin-impregnated, fiber-containing layers, wherein said pair of resin-impregnated, fiber-containing layers are laminated to said fiber-containing core layer; and
- (iii) a polyolefin adhesive web disposed between said fiber-containing core layer and each of said pair of resin-impregnated fiber-containing layers;

said composite joint having improved resistance to damage caused by externally applied forces;

wherein said fiber-containing core layer comprises poorly wetted or weakly bonded fibers.

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2. (Original) The composite joint of claim 1 wherein said fiber-containing core layer comprises polymeric fibers and said pair of resin-impregnated, fiber containing layers comprise glass fibers.
3. (Previously Presented) The composite joint of claim 1 wherein at least one of said pair of resin-impregnated, fiber-containing layers comprises a fiber having a first elongation at break, and said fiber-containing core layer comprises a fiber having a second elongation at break which is higher than said first elongation at break.
4. (Currently Amended) The composite joint of claim 1 wherein at least one of said pair of resin-impregnated fiber containing layers comprises a high tensile modulus fiber and said fiber-containing core layer comprises a roving, yarn, or tow, ~~poorly wetted or weakly bonded fibers~~.
- 5-6. (Cancelled)
7. (Original) The composite joint of claim 1 wherein said pair of resin-impregnated, fiber-containing layers and said fiber-containing core layer comprise two readily separable materials, amounting to at least 95 wt.% of said composite, for facilitating recyclability.
8. (Currently Amended) A bolted or riveted mechanically fastened composite structural joint, comprising:
 - (a) a substrate material;
 - (b) a multi-layered composite including:
 - (i) a pair of resin-impregnated, fiber-containing layers, having a first toughness ~~and a first tensile modulus~~;
 - (ii) a fiber-containing core layer having a second, greater toughness than said pair of resin-impregnated fiber-containing layers, ~~and a second tensile modulus that is lower than said first tensile modulus~~, said fiber-containing core layer sandwiched between said pair of

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resin-impregnated, fiber-containing layers wherein the fiber material of said pair of resin-impregnated, fiber-containing layers comprises a knit, woven or non-woven glass fabric having a basis weight of at least about 400 g/m², and the fiber material of the fiber-containing core layer comprises a woven or non-woven polymer fabric having a basis weight of at least 200 g/m²; and

(iii) a bolt or rivet fastener engaged with the substrate and composite materials to secure the materials together;

wherein said fiber-containing core layer comprises poorly wetted or weakly bonded fibers.

9. (Original) An aircraft or motor vehicle body panel or door comprising the composite joint of claim 1.

10. (Original) The composite joint of claim 1 wherein said fiber-containing core layer comprises a thermoplastic yarn, roving, tow, woven or non-woven fabric, mat, scrim or web.

11. (Original) The composite joint of claim 10 wherein said fiber-containing core layer is impregnated with a resin.

12. (Withdrawn) An energy absorbent laminate comprising:

(a) a pair of composite layers containing a resin-impregnated glass fabric or mat having a first toughness;

(b) a core layer laminated between said pair of composite layers having a second toughness which is greater than said first toughness, said core layer having a greater elongation at break than said first layer and containing poorly wetted or weakly bonded high tensile modulus fiber, roving, yarn, woven fabric, non-woven fabric, tow or combination thereof;

said core layer helping to at least distribute loads due to shear, cutting and impact forces exerted on said composite.

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13. (Withdrawn) The composite joint of claim 12 wherein said pair of composite layers comprise a woven or non-woven fabric or mat made of high tensile modulus fiber.

14. (Withdrawn) The composite joint of claim 12 wherein said core layer comprises low modulus polymeric filaments and filaments of at least one high modulus reinforcing fiber selected from the group comprising: glass fiber, carbon fiber, boron fiber, aramid fiber or a combination thereof.

15. (Withdrawn) A method of mechanically fastening a composite joint, comprising:

- (a) providing a substrate material;
- (b) providing a multi-layered composite, including:
 - (i) a pair of resin-impregnated, fiber-containing layers having a first toughness, each containing a fibrous layer having a basis weight of at least about 400 g/m²;
 - (ii) a fiber-containing core layer having a second higher toughness and containing a fibrous layer having a basis weight of at least about 200 g/m², said core layer sandwiched between said pair of resin-impregnated, fiber-containing layers;

said substrate material and said multi-layered composite having aligned through-holes therein for receiving at least one mechanical fastener;

- (c) disposing a mechanical fastener through said aligned through-holes of said multi-layered composite and said substrate material;
- (d) fastening said mechanical fastener to join said substrate material to said multi-layered composite, and
- (e) subjecting said multi-layered composite to a shearout load, whereby a force is directed in the plane of said multi-layered composite and said fiber-containing core helps to distribute said load.

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16. (Withdrawn) The method of claim 15 wherein said pair of resin-impregnated, fiber-containing layers are laminated to said fiber-containing core layer under heat, pressure, or both.
17. (Withdrawn) The method of claim 16 wherein said fiber-containing core layer comprises polymeric fibers and each of said pair of resin-impregnated, fiber-containing layers comprise glass fibers joined together in a roving, woven or non-woven fabric, yarn, tow, mat, scrim or combination thereof.
18. (Withdrawn) A multi-layered composite laminate, comprising:
- (a) a pair of resin-impregnated, fiber-containing layers having a first flexural modulus and a first toughness and a basis weight of at least 400 g/m²;
 - (b) a core layer having a second, lower flexural modulus than said first flexural modulus and a second higher toughness than said first toughness, said fiber-containing core layer sandwiched between said pair of resin-impregnated, fiber-containing layers to form an integral composite;
 - (c) said integral composite having improved shearout resistance over a composite of approximately the same thickness made entirely from said resin-impregnated, fiber-containing layers having a first flexural modulus.
19. (Withdrawn) The composite of claim 18 wherein said pair of resin-impregnated, fiber-containing layers and said fiber-containing core layer comprise substantially similar fiber compositions, resin compositions, or both, for improved recyclability.
20. (Withdrawn) A multi-layered composite having improved energy absorbing properties comprising:
- (a) a pair of resin-impregnated, fabric layers including high strength glass fibers, said fabric layer having a basis weight of at least about 400 g/m²; and
 - (b) a core layer for absorbing energy directed to said composite by externally applied forces, said core layer comprising polymeric fibers selected from

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nylon, rayon, polyester, acrylic, polyolefin or a combination thereof, said polymeric fibers having greater toughness than said high strength glass fibers, disposed in a roving, yarn, tow, knitted, woven or non-woven fabric, scrim or combination thereof, said core layer laminated between said pair of resin-impregnated glass fabric layers, under heat, pressure, or both, to form an integral composite.

21. (Withdrawn) The multi-layered composite of claim 20, wherein said core layer is only partially melted by said lamination.
22. (Withdrawn) A ballistic and explosion-resistant panel, comprising:
- (a) a pair of resin impregnated, glass fiber-containing layers, having a first toughness;
 - (b) an aramid fiber-containing core layer having a basis weight of at least about 300-6000 g/m² and a second, greater toughness than said first toughness, said core layer sandwiched between said pair of resin impregnated, fiber-containing layers;
- said multi-layered composite having improved resistance to ballistic impacts.
23. (Withdrawn) The panel of claim 21 wherein said aramid fiber-containing core layer comprises a woven or knit fabric.
24. (Cancelled)
25. (Withdrawn) A multi-layer composite having improved energy absorbing properties, comprising:
- (a) a pair of resin-impregnated, glass fabric layers; and
 - (b) a core layer for absorbing energy directed to said composite by externally applied forces, said core layer comprising polymer fibers within a polymeric matrix; said polymer fibers, polymeric matrix and said resin of said resin-impregnated glass fabric layers comprising the same resin.

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26. (Currently Amended) A bolted or riveted mechanically fastened composite structural joint, comprising:

- (a) a substrate material having a fastener hole;
- (b) a multi-layered composite material having a fastener hole, the composite material disposed over at least a portion of the substrate material so as to align the fastener holes of the substrate and composite materials;
and
- (c) a bolt or rivet fastener disposed within the fastener holes of the substrate and composite materials to secure the materials together;

wherein said composite material further includes:

- (i) a pair of resin-impregnated, fiber-containing layers having a first toughness ~~and a first tensile modulus~~; and
- (ii) a fiber-containing core layer having a second, greater toughness than said pair of resin-impregnated fiber-containing layers, ~~and a second tensile modulus that is lower than said first tensile modulus~~, said fiber-containing core layer sandwiched between said pair of resin-impregnated, fiber-containing layers; and

wherein said fiber-containing core layer comprises poorly wetted or weakly bonded fibers, and said fiber-containing core layer acts to absorb shear energy generated when a force is applied to said composite material via the bolt or rivet fastener.

27. (New) The composite joint of claim 1, wherein said pair of resin-impregnated, fiber containing layers have a first tensile modulus and said fiber-containing core layer has a second tensile modulus that is lower than said first tensile modulus.
28. (New) The composite joint of claim 8, wherein said pair of resin-impregnated, fiber containing layers have a first tensile modulus and said fiber-containing core layer has a second tensile modulus that is lower than said first tensile modulus.

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29. (New) The composite joint of claim 26, wherein said pair of resin-impregnated, fiber containing layers have a first tensile modulus and said fiber-containing core layer has a second tensile modulus that is lower than said first tensile modulus.